

CLAIMS

1. A 3D image display apparatus for making illumination light components of multiple wavelengths incident to a hologram, thereby generating reproduced light components of the wavelengths from the hologram, and displaying a 3D image based on these reproduced light components, said apparatus comprising:

a spatial light modulator having a discrete pixel structure for presenting holograms associated with the respective wavelengths;

an illumination optical system for converting each of the illumination light components of the wavelengths into a parallel plane wave and making the parallel plane waves incident from mutually different incident directions to said spatial light modulator;

a reproduced image transforming optical system for subjecting each of reproduced images of the wavelengths generated from the holograms presented on said spatial light modulator, to wavefront transformation into a virtual image or a real image; and

a mask with an aperture provided on a focal plane of said reproduced image transforming optical system,

wherein said illumination optical system sets the incident directions of the respective illumination light components of the wavelengths to said spatial

light modulator so that diffracted waves of any order of the respective reproduced light components of the wavelengths are superimposed on each other in said aperture after the wavefront transformation by said reproduced image transforming optical system.

2. A 3D image display apparatus according to claim 1, wherein said illumination optical system comprises a plurality of monochromatic light sources having their respective output wavelengths different from each other; a plurality of pinholes disposed in proximity to said respective monochromatic light sources; and a collimating optical system for collimating light having been emitted from each of said monochromatic light sources and having passed through said pinholes.

3. A 3D image display apparatus according to claim 1, wherein said illumination optical system comprises an achromatic lens having an identical focal length for the light components of the wavelengths.

4. A 3D image display apparatus according to claim 1, wherein said reproduced image transforming optical system comprises an achromatic lens having an identical focal length for the light components of the wavelengths.

5. A 3D image display apparatus according to claim 1, wherein said illumination optical system sets

the incident directions of the respective illumination light components of the wavelengths to said spatial light modulator so that zero-order diffracted waves of the respective reproduced light components of the wavelengths are superimposed on each other in said aperture after the wavefront transformation by said reproduced image transforming optical system.

6. A 3D image display apparatus according to claim 1, wherein said illumination optical system sets the incident directions of the respective illumination light components of the wavelengths to said spatial light modulator so that the illumination light component of any one specific wavelength out of the wavelengths is normally incident to said spatial light modulator and so that a zero-order diffracted wave of the reproduced light component of the specific wavelength and a higher-order diffracted wave of the reproduced light component of another wavelength are superimposed on each other in said aperture after the wavefront transformation by said reproduced image transforming optical system.

7. A 3D image display apparatus according to claim 6, wherein, where P represents a pixel pitch of said spatial light modulator, f a focal length of said reproduced image transforming optical system, n_1 an order of a diffracted wave of the reproduced light

component of the shortest wavelength λ_1 out of the wavelengths, and n_i an order of a diffracted wave of a reproduced light component of another wavelength λ_i , an incidence angle θ_i of the illumination light component of the wavelength λ_i to said spatial light modulator is expressed by the following equation:

$$\theta_i = \sin^{-1}\{(n_1\lambda_1 - n_i\lambda_i)/P\}, \text{ and}$$

wherein said aperture is of a rectangular shape having a length of not more than $\lambda_1 f/P$ on each side.

8. A 3D image display apparatus according to claim 1, wherein said spatial light modulator has a transmission type structure for emitting each of the reproduced light components on the side opposite to the side where the illumination light components are incident.

9. A 3D image display apparatus according to claim 1, wherein said spatial light modulator has a reflection type structure for emitting the reproduced light components on the same side as the side where the illumination light components are incident, and

wherein said illumination optical system and said reproduced image transforming optical system share one or more optical components.

10. A 3D image display apparatus according to claim 1, wherein said spatial light modulator has microlenses mounted for respective pixels.

11. A 3D image display method of making illumination light components of multiple wavelengths incident to a hologram, thereby generating reproduced light components of the wavelengths from the hologram, and displaying a 3D image based on these reproduced light components, said method comprising the steps of:

preparing a spatial light modulator having a discrete pixel structure for presenting holograms associated with the respective wavelengths;

letting an illumination optical system convert each of the illumination light components of the wavelengths into a parallel plane wave and letting said illumination optical system make the parallel plane waves incident from mutually different incident directions to said spatial light modulator;

letting a reproduced image transforming optical system subject each of reproduced images of the wavelengths generated from the holograms presented on said spatial light modulator, to wavefront transformation into a virtual image or a real image;

placing a mask with an aperture on a focal plane of said reproduced image transforming optical system; and

letting said illumination optical system set the incident directions of the respective illumination light components of the wavelengths to said spatial

light modulator so that diffracted waves of any order of the respective reproduced light components of the wavelengths are superimposed on each other in said aperture after the wavefront transformation by said reproduced image transforming optical system.

12. A 3D image display method according to claim 11, wherein said illumination optical system comprises a plurality of monochromatic light sources having their respective output wavelengths different from each other; a plurality of pinholes disposed in proximity to said respective monochromatic light sources; and a collimating optical system for collimating light having been emitted from each of said monochromatic light sources and having passed through said pinholes.

13. A 3D image display method according to claim 11, wherein said illumination optical system comprises an achromatic lens having an identical focal length for the light components of the wavelengths.

14. A 3D image display method according to claim 11, wherein said reproduced image transforming optical system comprises an achromatic lens having an identical focal length for the light components of the wavelengths.

15. A 3D image display method according to claim 11, wherein said illumination optical system sets the incident directions of the respective illumination

light components of the wavelengths to said spatial light modulator so that zero-order diffracted waves of the respective reproduced light components of the wavelengths are superimposed on each other in said aperture after the wavefront transformation by said reproduced image transforming optical system.

16. A 3D image display method according to claim 11, wherein said illumination optical system sets the incident directions of the respective illumination light components of the wavelengths incident to said spatial light modulator so that the illumination light component of any one specific wavelength out of the wavelengths is normally incident to said spatial light modulator and so that a zero-order diffracted wave of the reproduced light component of the specific wavelength and a higher-order diffracted wave of the reproduced light component of another wavelength are superimposed on each other in said aperture after the wavefront transformation by said reproduced image transforming optical system.

17. A 3D image display method according to claim 16, wherein, where P represents a pixel pitch of said spatial light modulator, f a focal length of said reproduced image transforming optical system, n_1 an order of a diffracted wave of the reproduced light component of the shortest wavelength λ_1 out of the

wavelengths, and n_i an order of a diffracted wave of a reproduced light component of another wavelength λ_i , an incidence angle θ_i of the illumination light component of the wavelength λ_i to said spatial light modulator is expressed by the following equation:

$$\theta_i = \sin^{-1}\{(n_1\lambda_1 - n_i\lambda_i)/P\}, \text{ and}$$

wherein said aperture is of a rectangular shape having a length of not more than $\lambda_1 f/P$ on each side.

18. A 3D image display method according to claim 11, wherein said spatial light modulator has a transmission type structure for emitting each of the reproduced light components on the side opposite to the side where the illumination light components are incident.

19. A 3D image display method according to claim 11, wherein said spatial light modulator has a reflection type structure for emitting the reproduced light components on the same side as the side where the illumination light components are incident, and

wherein said illumination optical system and said reproduced image transforming optical system share one or more optical components.

20. A 3D image display method according to claim 11, wherein said spatial light modulator has microlenses mounted for respective pixels.